VEGA
VULNERABILITY OF ELECTRIC POWER GRIDS ANALYZER

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"THE SUMMER TRIANGLE" (Vega, Deneb, and Altair) -- 24mm Nikon lens for 7.5 minutes at f/2.8 -- hypered Fuji 800 Super G Plus -- by ANDY STEERE

What is VEGA?

VEGA is a tool for analyzing the vulnerability and defense of electric power systems under threats posed by terrorist attacks.

- **VEGA determines the worst possible disruption that could be caused by a terrorist attack,**
- **Compares multiple attack plans terrorists might undertake under different resource-constrained assumptions,**
- **Assesses security enhancement through preemptive measures, and**
- **VEGA is based on powerful optimization**

Integrating Three Levels of Optimization

- Level 1: Optimal power flow model to minimize "disruption":

(disruption = load shedding + increased costs)

Data: Power grid data

- Level 2: Interdiction model to maximize "Level-1 disruption"

Data: Power grid data and terrorist resources

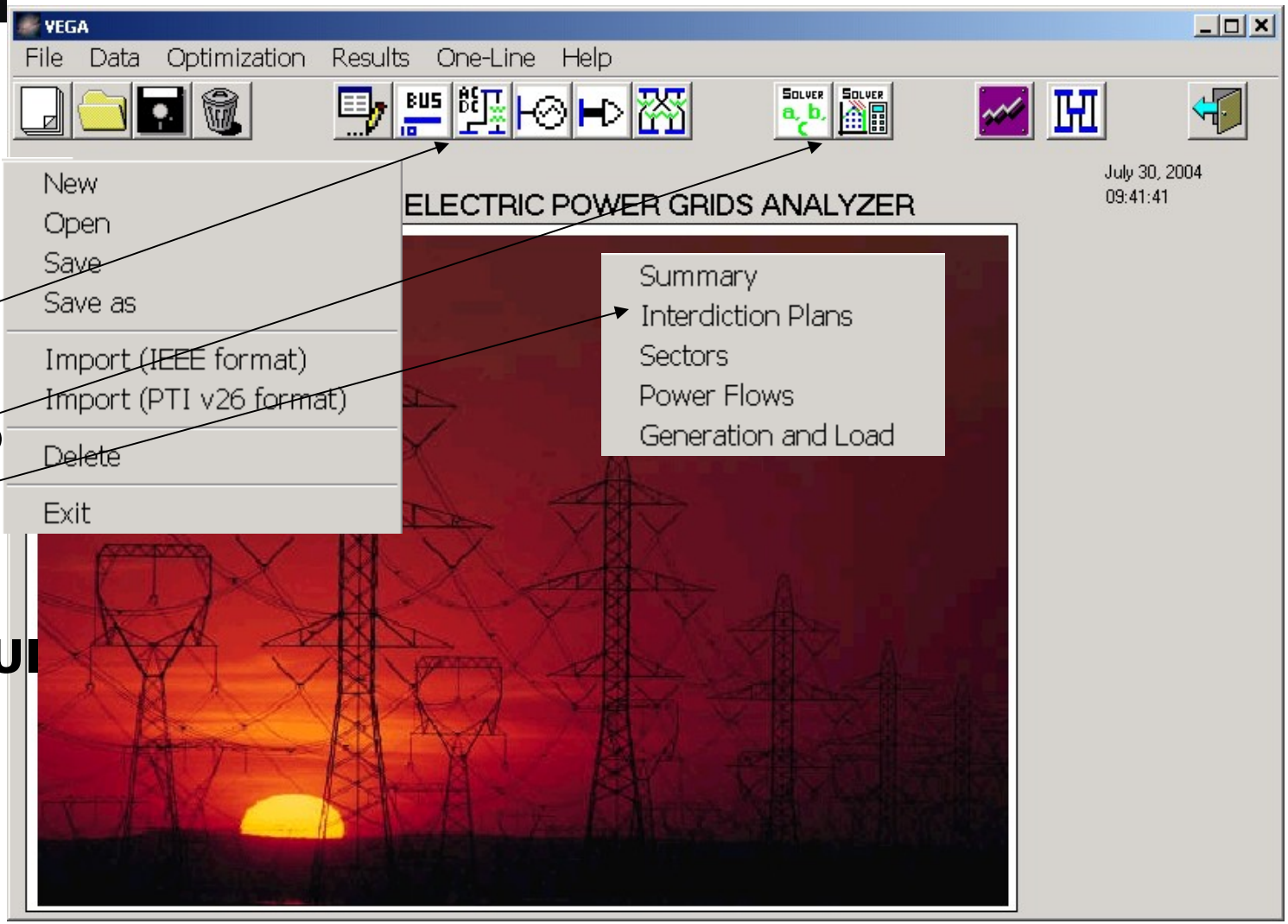
- Level 3: Protective model to minimize "Level-2 interdiction"

Data: Power grid data, terrorist resource and counter-terrorist resources (budget for expansion, spares, upgrades, hardening)

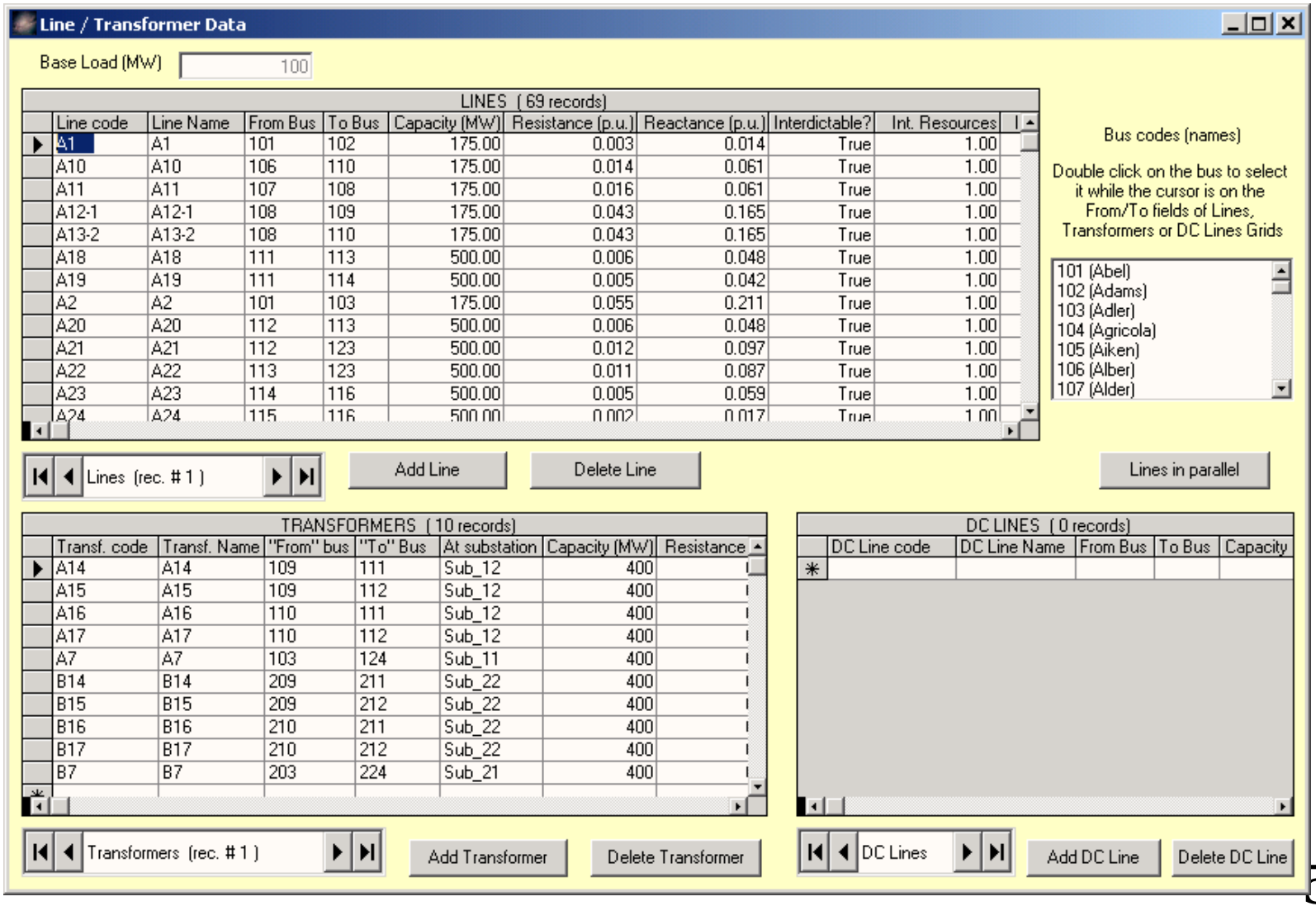
VEGA

Main Menu:

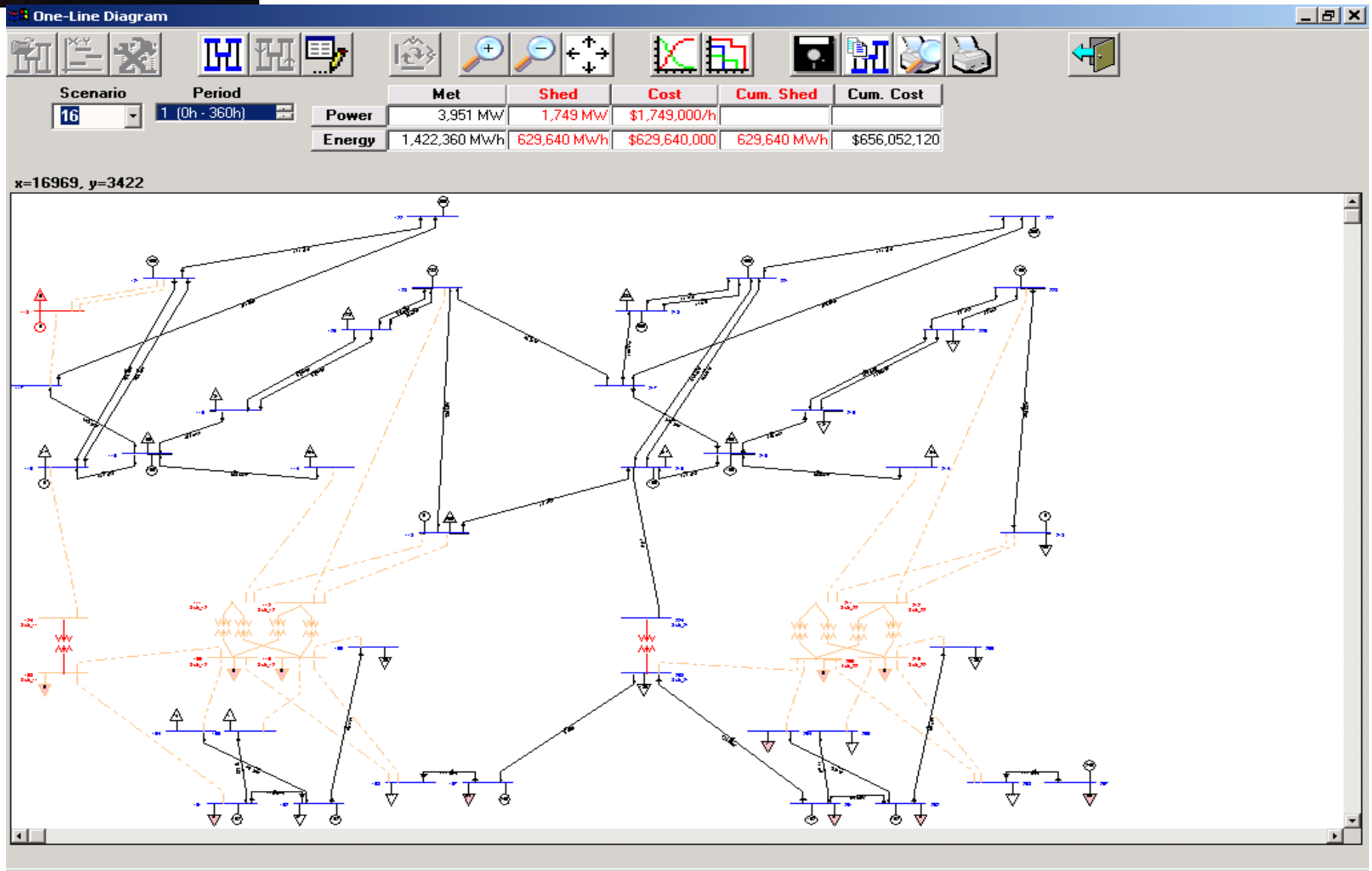
- **File mgmt.**
- **Grid data**
- **Optimizatio**
- **Results**
- **One-Line GUI**
- **Help**



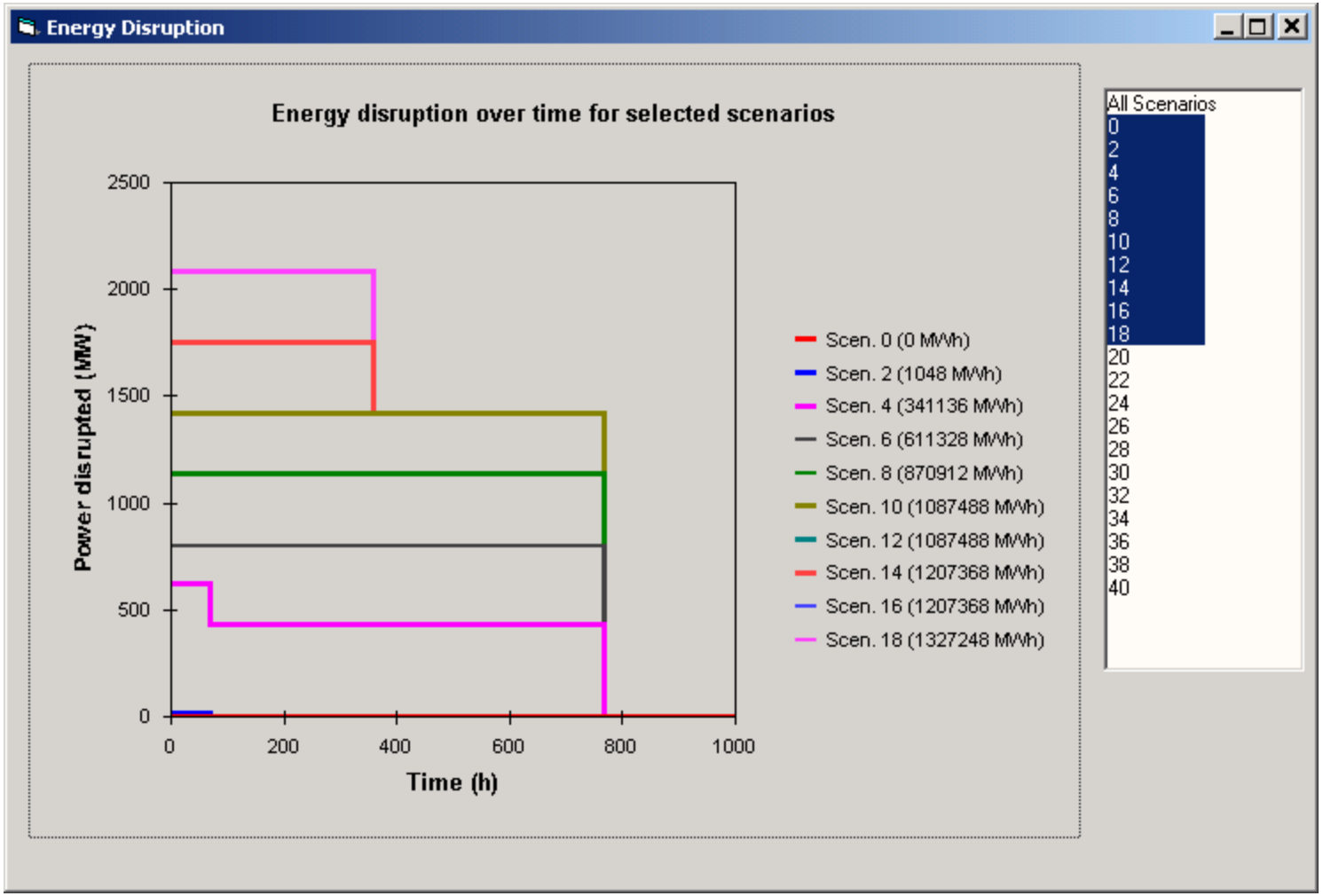
Power Grid Data



One-Line GUI: Power Flow After Optimal Interdiction



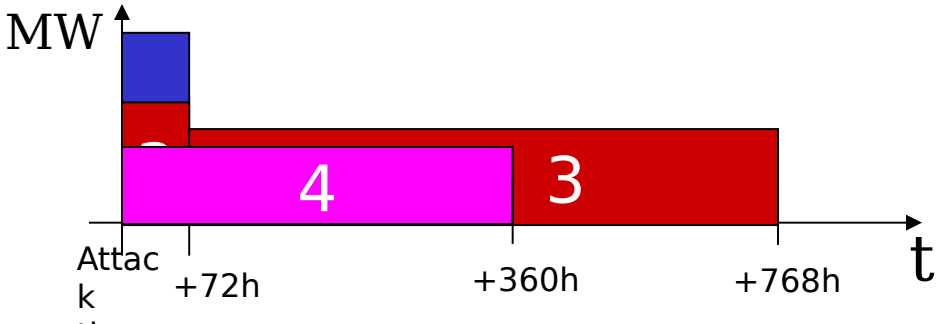
Energy Disruption over Time

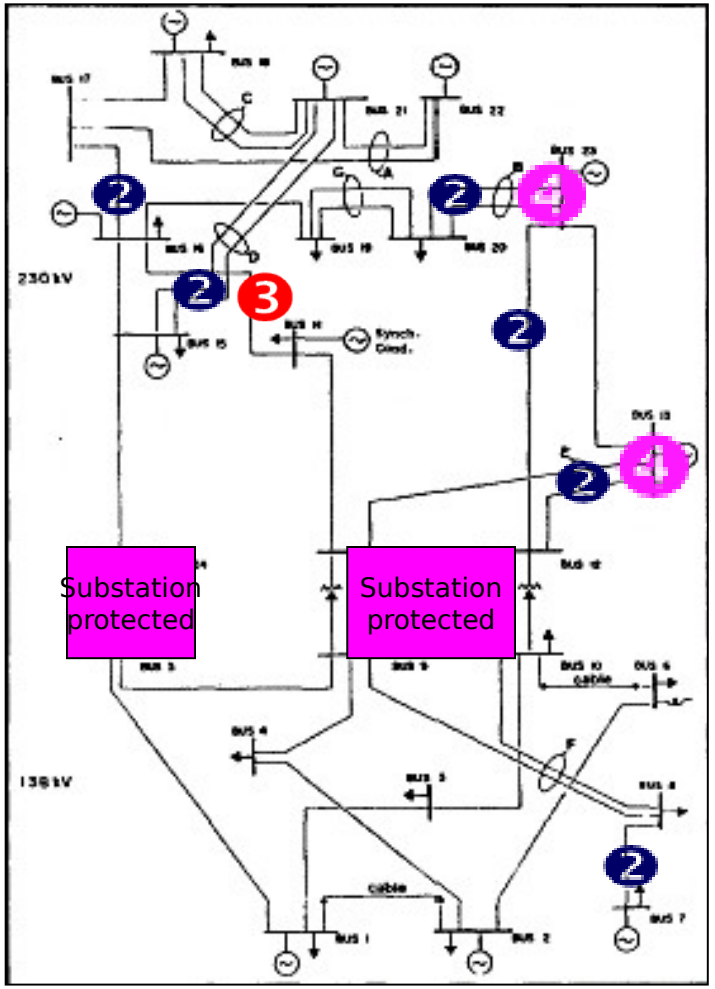


Optimizing Disruption over Time with System Restoration

Total Load: 2,850 MW

Attack Plan	Time Period	Power Shed (MW)	Energy Shed (MWh)
2	0-72 h	1,373	98,856
			Total: 98,856 MWh
3	0-72 h	902	64,944
	72-768 h	708	492,768
			Total: 557,712 MWh
4	0-360 h	756	272,160
			Total: 272,160 MWh





Salmeron, Wood and Baldick, *IEEE Trans. on Power Systems*, May 2004

Technical Features

- **Hardware**

  500 MHz processor

  1Gb RAM

- **Operating system**

  Windows 98, 2000, XP or above

Prototype Features

	VEGA 1.0	VEGA 2.0	VEGA 3.0
Expected date	Jun-03	Jun-04	Jun-05
Database interface	X	X	X
Network interface	X	X	X
Grid size limit	100 buses	1000 buses	1000+ buses
Disruption analysis	Pseudo-optimal	Optimal	Optimal
Disruption period	Short-term	Short- and Long- term	Short- and Long- term
Analysis of protective measures	Manual	Manual	Optimized automatically